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HOSPITALIZATION RATES OF TUBERCULOSIS IN

U.S. NAVY ENLISTED PERSONNEL:

A 15-YEAR PERSPECTIVE

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Summary

The epidemiology of tuberculosis in this country is changing because of a combination of biological and social factors. The recent use of DNA fingerprinting of *Mycobacterium tuberculosis* using restriction-fragment-length polymorphism (RFLP) analysis, has suggested that nearly one third of new cases of tuberculosis being reported in a large metropolitan city is a result of recent infection.¹ The immunosuppression of individuals with the human immunodeficiency virus (HIV), and the prevalence of multiple drug-resistant tuberculosis (MDR-TB), has resulted in a renewed interest in the epidemiology and prevention of this disease. To determine the magnitude of the problem in the U.S. Navy enlisted population, a computer search of more than one million inpatient hospitalization records from January 1980 to December 1994 was performed. Total first hospitalization rates for all cases of tuberculosis during this period ranged from 2.2/100,000 person-years at risk in white females, to 27.5 in males, race "other" (includes mostly Filipinos, and Asian-Americans). First hospitalization rates across all cases of tuberculosis declined during this period from a high of 8.7/100,000 in 1980 to a low of 2.2/100,000 in 1994.

Hospitalization Rates of Tuberculosis in U.S. Navy Enlisted Personnel: A 15-Year Perspective

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INTRODUCTION

Tuberculosis (TB) has been a scourge of mankind since ancient times, and even today it remains one of the foremost causes of disability and death throughout the world.² Despite decades of successful control and decreasing rates in the United States, TB is making a comeback. In 1992, 26,673 cases of active TB were reported to the Centers for Disease Control, up 20% from 1985, when resurgence of the disease began. Twenty-two states in 1992 reported increases over 1991 in the number of TB cases reported. The largest increases occurred in Virginia (20.6%), Illinois (6.5%), New York (3.3%), and California (2.1%).³ The primary factors thought to be responsible for this increase in TB incidence are immigration from high-prevalence countries; coinfection with HIV; social disruption, including homelessness and drug abuse; outbreaks of TB which occur in congregative facilities; and the recent appearance of multiple drug-resistant TB.⁴

The worldwide incidence of TB is expected to increase substantially over the next 10 years. An estimated 7.5 million incident cases of TB occurred worldwide during 1990. Approximately 4.9 million cases (66%) occurred in the Southeast Asian and Western Pacific regions; India (2.1 million), China (1.3 million), and Indonesia (0.4 million) accounted for the largest number of cases. On April 23, 1993, the World Health Organization declared TB a global public health emergency, a distinction never accorded another disease.⁵ All recruits entering the Navy are screened for a number of diseases, including both HIV and TB. Those with a positive tuberculin skin test are given therapy to prevent the development of active

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TB and allowed to enter the service; those testing positive for HIV are denied entrance. During this routine screening, the rate of newly identified tuberculin reactors historically has been no more than 1 to 5%. In addition, all Navy personnel have periodic screenings and are required to have a recent (one-year or less) tuberculin skin test before leaving the service.⁶ Once a person is infected, the lifetime risk of developing active TB is 5 to 10%; this compares with a lifetime risk of at least 30% in HIV-infected persons who were previously infected or recently exposed to TB.⁷

The threat posed by this infectious disease is increased for those individuals in the U.S. military who are called upon to operate in countries where TB is endemic or on the increase. In addition, other social and environmental factors such as communal living, increase the risk of contact with infectious individuals. Epidemics of TB have been reported among persons congregated in enclosed spaces, a situation not uncommon during military operations; and the Navy continues to experience local outbreaks of TB infection aboard ships. An outbreak of TB that occurred aboard the USS Saipan in 1987, found that one individual had infected 216 (24.5%) of the ship's crew.⁸ Another extensive investigation of TB aboard the USS Richard E. Byrd in 1968 found 48% of the ship's crew were infected as a result of exposure to one sailor with cavitary pulmonary TB. Naval ships with their large crews, closed environments, and controlled ventilation systems appear to be ideal settings for the transmission of TB.⁹

The objective of this study was to review the hospitalization rates of TB among U.S. Navy enlisted personnel during the period 1980 through 1994 in order to identify long-term trends and risk factors that may be helpful in augmenting the Navy's current TB control and prevention program.⁶ Effective intervention will continue to require an aggressive control program in order to stem the spread of TB and prevent MDR-TB from becoming widespread.

MATERIALS AND METHODS

The Naval Health Research Center, San Diego, CA, maintains a Epidemiological Interactive System (EPISYS),^{10,11} which is a computerized medical information system that provides medical planners and researchers with access to select information contained in more than one million inpatient medical history records. These data are obtained quarterly from the Naval Medical Information Management Center, Bethesda, Maryland, (formally the Naval Medical Data Services Center). The records are then combined with data from demographic, occupational, and other service history information provided by the Navy Military Personnel Command in Washington, DC.¹² These files provide all hospitalizations, demographic and career histories for all Navy enlisted personnel serving on active duty anytime during January 1, 1980 to December 31, 1994 (1,147,015 inpatient records). To ensure confidentiality, all identifying information was removed before the data were analyzed.

Medical history files were searched for any case having a diagnosis of TB as defined by the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes 010.0-018.9.¹³ Cases were included in this study if any of these codes appeared on their inpatient medical record anytime during January 1, 1980 to December 31, 1994. If a patient was admitted more than once during the study period for the same diagnosis of TB, or if dissemination by lymphohematogenous from the original site occurred, only the first hospitalization was used to determine a true hospitalization incidence rate of TB. Tuberculosis late effects, ICD-9-CM code 137, was not included in the analysis because this category generally is used to indicate conditions classifiable to 010-018, (ie., cases already selected for inclusion). Although most individuals who have TB do not require hospitalization, in the military when individuals are diagnosed with an infectious disease like TB, they usually are hospitalized in an effort to control the spread of the disease, or until appropriate drug therapy can be initiated.

A Population Denominator File provided average annual person-years at risk (7,408,712 total person-years) for all active-duty enlisted personnel for the 15-year study period. Variables analyzed in this study included TB diagnosis, HIV status, age, race, sex, occupation, ship type, place of residence, and year hospitalized. Age-adjusted hospitalization rates were calculated using the total active-duty enlisted population as the standard population. Ninety-five percent confidence intervals were calculated for hospitalization rates of TB and associated variables assuming a Poisson process.

RESULTS

EPISYS identified 408 first hospitalizations with a diagnosis of TB. Approximately 84% were either pulmonary TB (74.3%) or other respiratory TB (9.6%) (Table 1). The average annual first hospitalization rate during this 15-year period across all cases was 5.5/100,000 person-years. From 1980 to 1994, total first hospitalizations for TB overall declined from a high of 8.7/100,000 person-years in 1980 to a rate of 2.2/100,000 person-years in 1994. Race "other," which includes mostly Filipinos and Asian-Americans, showed the highest hospitalization admissions over this time period (Fig. 1). As a group, their hospitalization rates have declined from a high of 55.5/100,000 person-years in 1980 to 12.4/100,000 person-years in 1993, the last year with complete data for this group. Approximately 47% of individuals in this group listed a foreign country as their place of residence at time of entry into the Navy.

Analysis of hospitalization admission rates by sex and race demonstrated a consistent pattern for both males and females (Table 2). Male and female Filipinos and Asian-Americans showed the highest rates (26.6 and 14.7/100,000 person-years, respectively). Next were black females (9.8/100,000 person-years) and black males (8.8/100,000 person-years). The lowest rates were observed in white males (3.2/100,000 person-years), and white females (2.2/100,000 person-years), these rates are consistent with those generally observed in the civilian population where in 1991, 70% of all

Table 1

First hospitalization admissions for tuberculosis by ICD-9-CM diagnostic classification, active-duty enlisted naval personnel, 1980-1994

Tuberculosis Classification	ICD-9-CM code	No.	%
Pulmonary tuberculosis †	011	303	74.3
Other respiratory tuberculosis	012	39	9.6
Tuberculosis of meninges and CNS	013	7	1.7
Tuberculosis of intestines, peritoneum, and mesenteric glands	014	3	0.7
Tuberculosis of bones and joints	015	16	3.9
Tuberculosis of genitourinary system	016	11	2.7
Tuberculosis of other organs	017	22	5.4
Miliary tuberculosis	018	7	1.7
Total		408	100.0

† No ICD-9 code 010, Primary tuberculous infection, was reported.

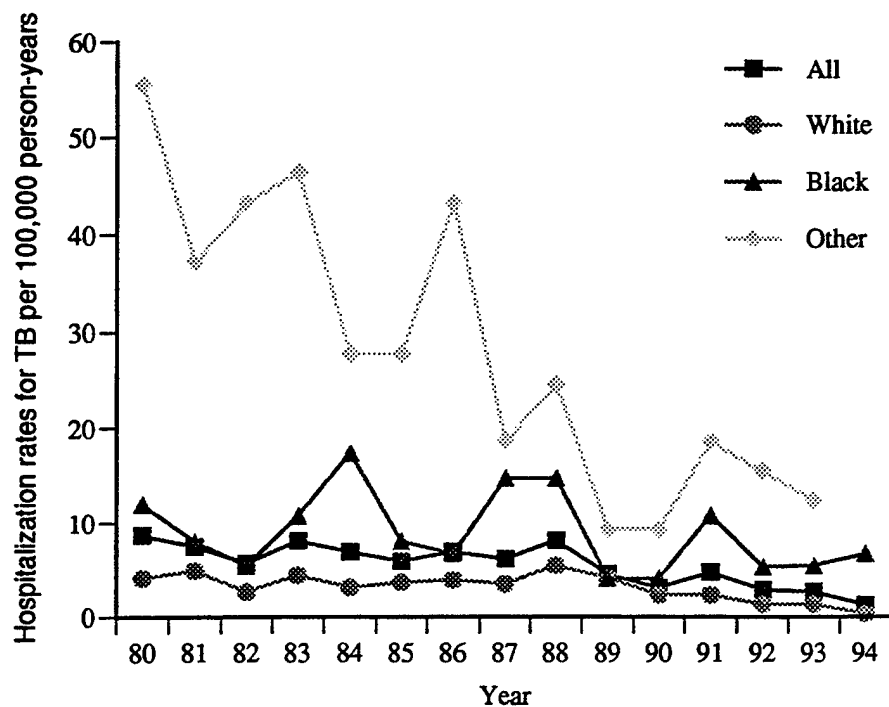


Fig 1. Hospitalization rates for TB, by race and year, in active duty U.S. Navy enlisted personnel, 1980-1994.

reported cases of TB occurred among racial and ethnic minority groups.⁴

Analysis of hospital admission rates by sex and age demonstrated that the risk of TB in males increases significantly with age (Fig. 2). The highest rate in males (23.0/100,000 person-years) was

Table 2
First hospitalization admissions for TB by sex and race, active-duty enlisted naval personnel, 1980-1994

Male	<u>No. of Cases</u>	<u>Per-Yrs at Risk</u>	<u>Incidence Rate*</u>	<u>CI Lower</u>	<u>CI Upper</u>
White	171	5,313,483	3.2	2.7	3.7
Black	85	967,494	8.8	6.9	10.6
Other [†]	122	458,327	26.6	21.9	31.3
Total	378	6,739,304	5.6	5.0	6.2
Female					
White	11	488,657	2.2	0.9	3.6
Black	15	153,590	9.8	4.8	14.7
Other [†]	4	27,161	14.7	0.6	28.9
Total	30	669,408	4.5	2.9	6.1
Pop Total	408	7,408,712	5.5	5.0	6.0

[†] Includes Filipinos, Asian-Americans and Native Americans.

* Cases per 100,000 person-years at risk

observed in the age group 45-61, whereas in females the highest rate was in the age group 20-21 (6.9/100,000 person-years). The increase in TB with age observed in males may be reflecting an activation of infection that had been acquired many years earlier. The lifetime risk of developing TB after infection is 5 to 10%; therefore, it seems likely some of the cases appearing in the older males are a result of a prior infection. In females, however, no cases were reported in anyone older than 34; this is in part a reflection of the younger age distribution of females compared with males. The cases occurring in the age group 20-21 may represent newly acquired infections.

One of the factors considered to be responsible for the increase in TB in this country and throughout the world is coinfection with HIV. Approximately 5.5% of U.S. Navy enlisted personnel who tested positive for HIV had an active TB infection. Matching of HIV and TB case registries in the civilian population has shown similar percentages of approximately 5%, although in one seroprevalence survey of TB clinics in 20 cities, the range was from 0-61%.⁴ Although the association between TB and HIV infection is not clear, current research suggests that HIV infection increases TB morbidity principally by increasing progression from TB infection to active TB.¹⁴ Tuberculosis is the only HIV-associated respiratory pathogen that can be transmitted from human to

human by close casual contact, and it constitutes an important opportunistic infection among HIV-infected individuals.⁷ The diagnosis of *Mycobacterium tuberculosis* in HIV individuals is a particular problem because these individuals may be anergic, often have atypical radiograms, and may be coinfecting with *Pneumocystis carinii*.⁴ Studies on therapy of people with TB and HIV infection have shown that standard treatment regimens are associated with increased relapse rates, increased mortality, and increased rates of side effects from these drugs.^{15, 16, 17}

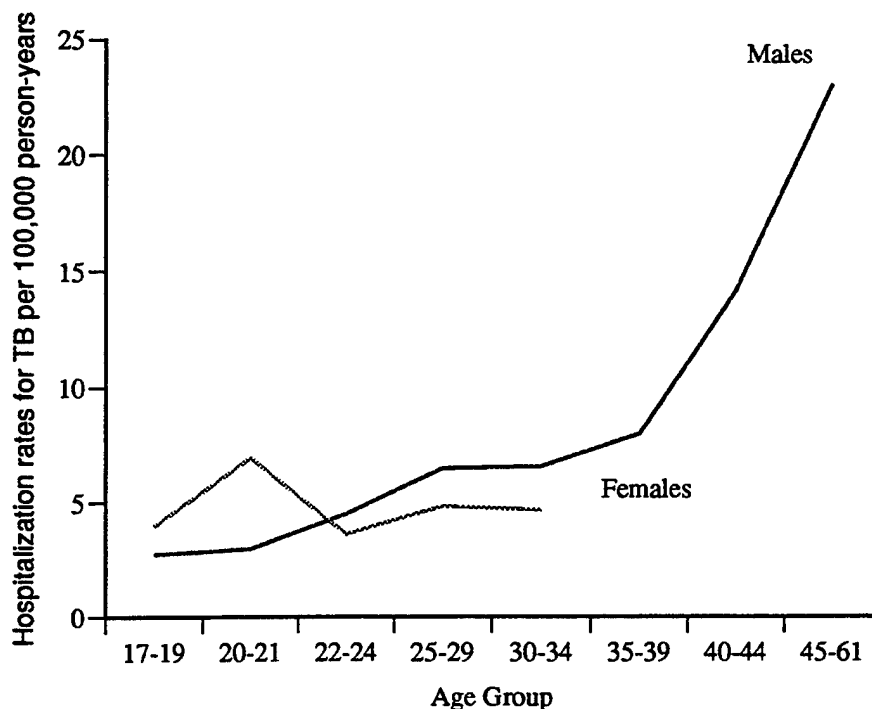


Fig. 2. Hospitalization rates for TB by sex and age group, U.S. Navy enlisted personnel, 1980-1994.

Little is known of the occupational risks of becoming infected with TB or of developing the disease following infection.² Among hospital employees, the differences were slight in the number of positive tuberculin reactors by type of job or estimated exposure to patients.¹⁸ When compared with the overall Navy rate of 5.5/100,000 person-years; 95% CI 4.9-6.0, analysis of risk by occupation in the US Navy enlisted population demonstrated a significantly higher rate in 3 occupations: Mess Management Specialist (11.9/100,000 person-years; 95% CI 7.7-16.0), Firemen (14.5/100,000 person-years; 95% CI 7.4-21.5), and Seaman Recruit (18.4/100,000 person-years; 95% CI 7.4-21.6). However, these 3 occupations accounted for 35.7% of all case of

TB appearing in the race group "other," which was shown to have the highest TB rate in the Navy. Consequently, this distribution of the race group "other" across the Navy work force resulted in a higher than expected incidence rate of TB within these 3 occupational groups. When controlling for the fact that males, race "other," and older individuals all had higher rates of TB, it was shown that occupation had no effect on the incidence of TB in the U.S. Navy enlisted population.

To determine if shipboard environments represent a risk factor for becoming infected with TB, naval ships were grouped into 19 categories and their rates of TB were determined and compared across each category of ship type and with shore-based stations. Only those ship categories that had cases are shown in Table 3. As indicated, no ship type categories showed significantly higher rates than those for shore-based stations.

Table 3

First hospitalization admissions for TB by ship type, active-duty, enlisted naval personnel, 1980-1994

Ship Category	No of Cases	Per-Yrs at Risk	Incidence Rate	CI Lower	CI Upper
Aircraft Carrier	28	353,229	7.9	5.0	10.8
Aircraft Carrier, Nuclear	9	184,501	4.9	1.7	8.0
Battleship/Cruiser	9	169,939	5.3	1.9	8.7
Cruiser, Nuclear	2	69,130	2.9	4.0	5.8
Destroyer/Frigate	35	587,423	6.0	4.0	7.9
Amphibious Assault	23	340,549	6.7	1.9	9.5
Material Support	15	388,303	3.9	1.9	5.8
Underway Replenishment	10	196,356	5.1	0.1	8.2
Submarine	3	4,681	64.1	0.0	128.2
Submarine Attack, Nuclear	4	163,218	2.4	0.0	4.8
Submarine Ballistic Missile, Nuclear	1	133,106	0.7	0.0	1.5
Auxiliary/Non-combatant	1	24,110	4.1	0.0	8.3
All Ship Types	140	2,635,339	5.1	4.2	5.9
Ashore	268	4,639,893	5.8	5.1	6.5
Pop Total	408	7,408,712	5.5	5.0	6.0

The hospitalization rate for TB while at a shore station was 5.8 /100,000 person-years; 95% CI 5.1 - 6.5, and the shipboard hospitalization rate across all ship types was 5.1/100,000 person-years; 95% CI 4.2 - 5.9. Although naval ships with their large crews, closed environments, and controlled ventilation systems have been settings for the transmission of TB, no excess risk appears to be associated with these environments when compared with shore-based stations when analyzed over a 15-year period. However, being in a indoor or restrictive environment with an individual who has infectious pulmonary TB will substantially increase one's risk of becoming infected, as shown by passed outbreaks of TB onboard ships.^{8,9}

DISCUSSION

Between 1980 and 1994, first hospitalization rates in U.S. Navy enlisted personnel for TB have declined from a high of 8.7/100,000 person-years to a low of 2.2/100,000 person-years in 1994. In the civilian population, TB incidence rates have been declining approximately 5-6% per year from 1953 through 1984.¹⁴ However, starting in 1987 a resurgence of TB in the United States began to occur and has raised concern that TB may be returning to prominence as a major public health problem. The primary factors considered responsible for this increase in TB incidence are immigration from high-prevalence countries; coinfection with HIV; social disruption including homelessness; and the recent appearance of MDR-TB.

The highest rates of active TB in the U.S. Navy enlisted population were observed in males, particularly older males from the race group "other." As mentioned previously, this group consists primarily of Filipinos, and Asian-Americans. Even though their hospitalizations rates as a group have declined from a high of 55.5/100,000 person-years in 1980 to 12.4/100,000 person-years in 1993, this increased risk for active TB in this group has remained consistent for almost 40 years. During the period from 1958 through 1969, Comstock and colleagues¹⁹ tested 1,216,425 U.S. Navy recruits with 5 tuberculin units of PPD-S on entry to the service. Approximately 5% were tuberculin reactors at that time, and the incidence of active TB was found to be highest for Asians who were mostly Filipinos, intermediate for blacks, and lowest for whites, a pattern still being observed in the Navy today. They also found that of the reactors, the chance of developing an active case of TB during the first 4 years of enlistment was related to their tuberculin sensitivity on entry, ethnic group, place of residence before entering the Navy, and history of contact with a person or family member with TB. Although it was not possible in this study to determine the percentage of endogenous infections in relation to newly acquired TB, the observation that Filipinos and Asian-Americans historically have shown higher rates for TB suggests a likely reactivation of earlier infections are occurring, particularly in older males. The percentage of excess TB cases in this group attributable to having a

foreign residence prior to enlisting could not be determined; however, it is noteworthy that 47% reported a foreign place of residence. The increased risk of TB among immigrants is primarily a consequence of higher rates of TB in many foreign countries compared with the relatively low rates in the United States. This is particularly true for immigrants from the Philippines and other Asian nations.

There was no excess risk observed across any of the job occupations after controlling for age, sex, and race. This was also true for the 19 categories of ship type. Rates for shore-base stations were not significantly different from any of the categories of ship type. The risk factors identified in this study for having an active case of TB were primarily related to ethnic group, age, sex, and whether a foreign country was listed as your place of residence before enlisting. These are similar to the risk factors that Comstock found in Navy recruits more than 30-years ago.¹⁹

The observed downward trend of TB in the Navy over the last 15-years is encouraging. This decline has continued even during a resurgence of TB in the United States that began in 1987. Several apparent differences between civilian and military populations probably account for this. First, the Navy maintains an active program for TB surveillance and control, which includes routine tuberculin skin testing; contact investigation; and treatment of active cases, convertors, contacts, and selected reactors.⁸ Secondly, with the exception of a special treaty granting the right of citizens of the Republic of the Philippines to enlist in the Navy, immigration from high-prevalence countries does not affect the military to the same extent as the civilian population. In addition, since screening for HIV began in 1985, no one is allowed to enter the Navy with HIV, and, as a result, fewer individuals will be infected with HIV. Consequently, the development of HIV-associated TB will also decrease overtime.

During 1995, seroprevalence rates for HIV per 1,000 civilian applicants wanting to join the military service were the lowest since screening began in 1985. This is encouraging news for both the control of HIV and TB infections.²⁰ The continued downward trend of TB in the Navy speaks well for the effectiveness of its TB control program. However, with the ongoing deployment of military personnel to areas of the world where TB is prevalent, a constant vigil will be required to ensure this downward trend continues.

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